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(54) **METHODS AND APPARATUS FOR PARTIAL ENCRYPTION OF TOKENIZED DOCUMENTS**

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(52) **U.S. Cl.** **713/168**; 713/172; 713/179; 713/185
(58) **Field of Search** 713/168, 172, 713/179, 185, 200, 201

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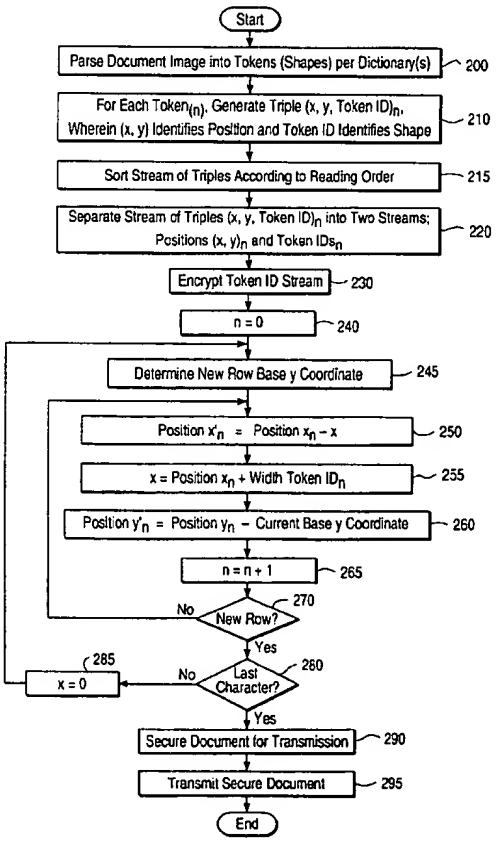
(57) **ABSTRACT**

A technique that partially encrypts tokenized documents is disclosed. An electronic document image is generated from the document. A plurality of tokens are stored as a dictionary, wherein the tokens represent shapes contained in the document. A plurality of triples comprising a token identification (ID) and a corresponding position are generated from the document image, such that the token ID identifies a token from the dictionary that corresponds to a shape in the document image at the corresponding position. The token IDs are encrypted. The output representation for the secured document comprises encrypted token IDs, positions and a dictionary of tokens. Encoding techniques that reduce the size of the secured document are also disclosed. A trusted image output terminal, for use in document reconstruction, includes a single integrated circuit that performs the decrypting function and the page rendering function to significantly reduce the ability to capture the electronic document in the clear.

24 Claims, 7 Drawing Sheets



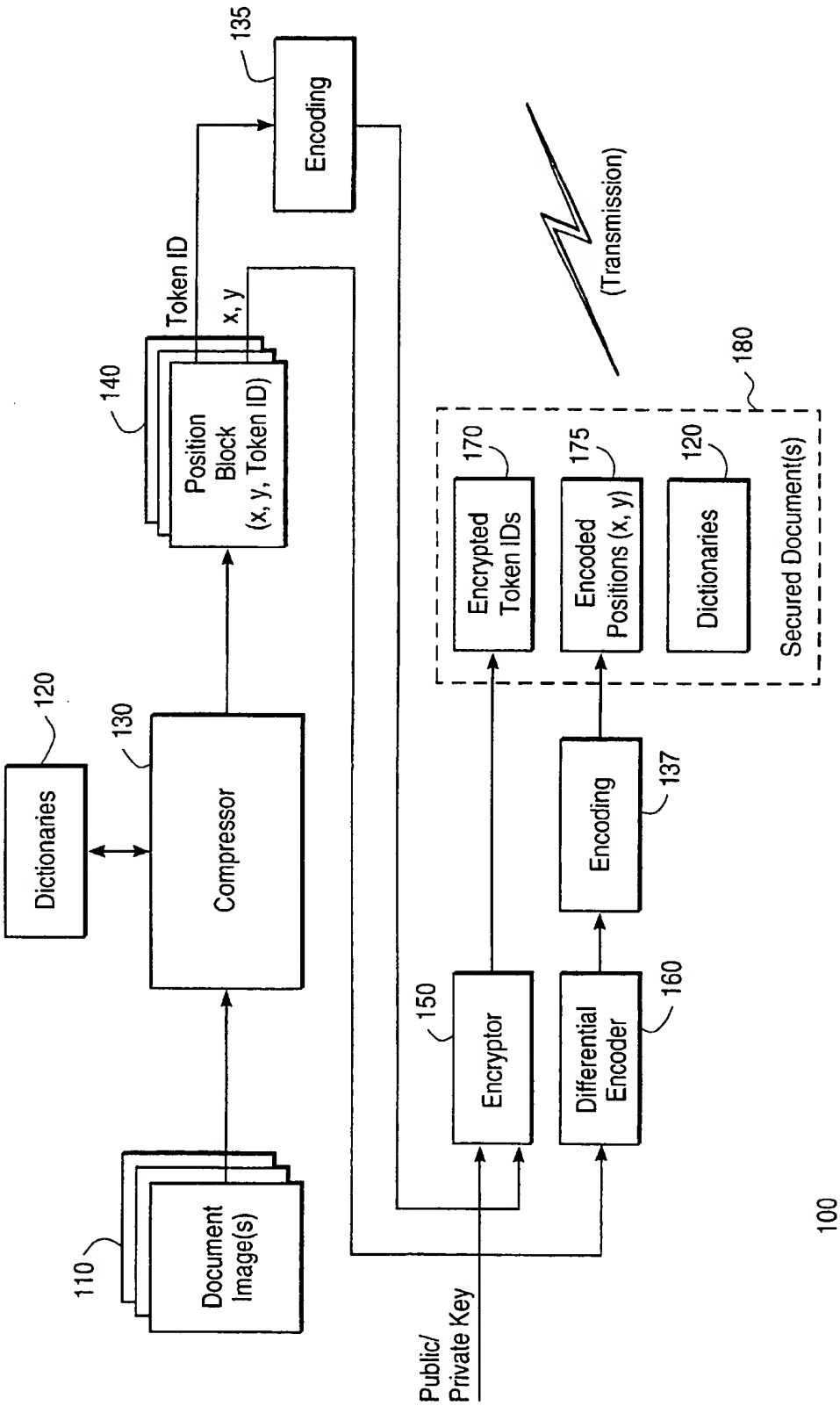

Document Image(s)
110
Dictionaries
120
Compressor
130
Position Block (x, y, Token ID)
140
Token ID
x, y
Encoding
135
Public/ Private Key
Encryptor
150
Differential Encoder
160
Encoding
137
Encrypted Token IDs
170
Encoded Positions (x, y)
175
Dictionaries
120
Secured Document(s)
180
(Transmission)
100

FIG. 1

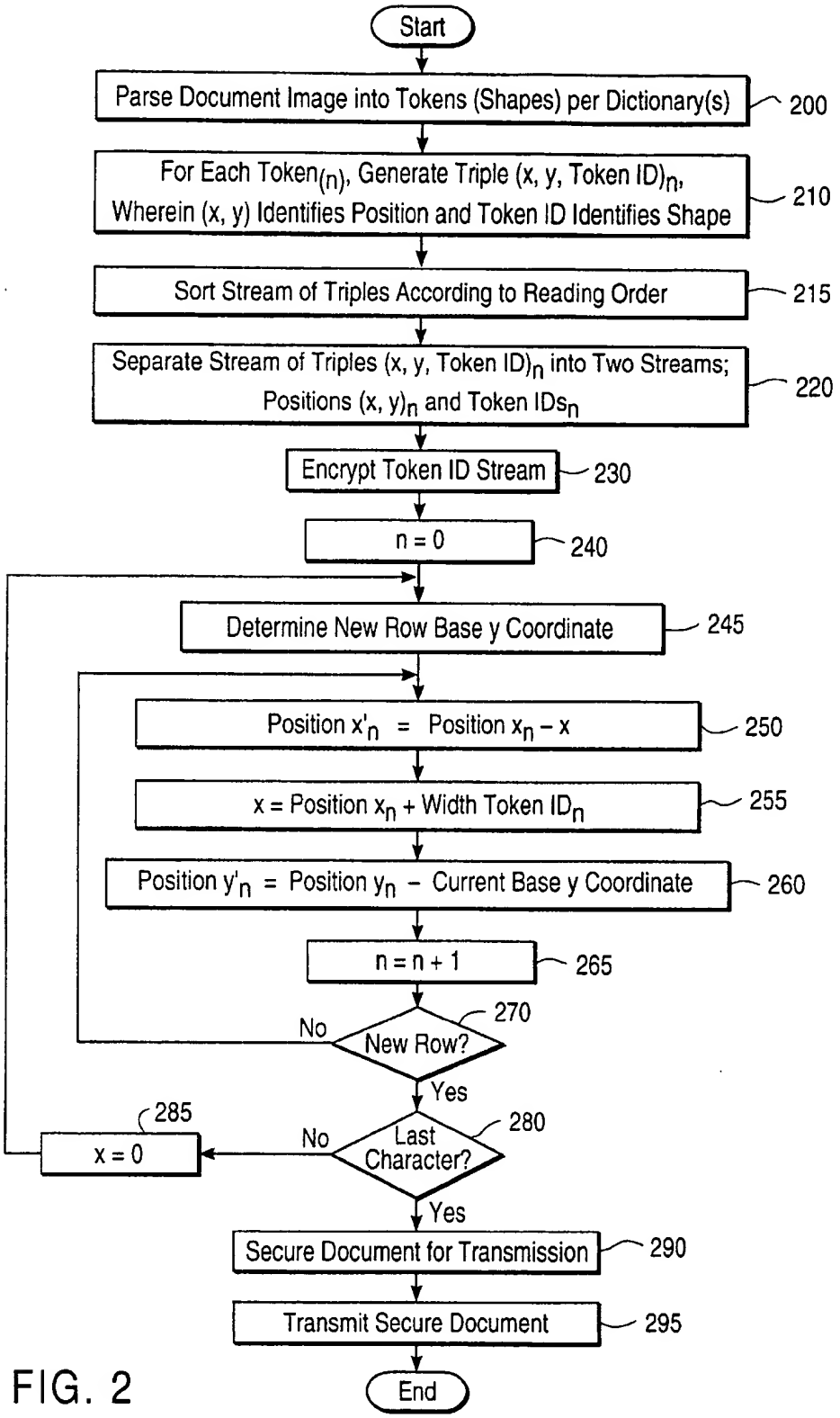

Start
Parse Document Image into Tokens (Shapes) per Dictionary(s)
200
For Each Token(n), Generate Triple (x, y, Token ID)n, Wherein (x, y) Identifies Position and Token ID Identifies Shape
210
Sort Stream of Triples According to Reading Order
215
Separate Stream of Triples (x, y, Token ID)n into Two Streams; Positions (x, y)n and Token IDsn
220
Encrypt Token ID Stream
230
n = 0
240
Determine New Row Base y Coordinate
245
Position x'n = Position xn – x
250
x = Position xn + Width Token IDn
255
Position y'n = Position yn – Current Base y Coordinate
260
n = n + 1
265
New Row?
270
No
Yes
Last Character?
280
No
x = 0
285
Yes
Secure Document for Transmission
290
Transmit Secure Document
295
End

FIG. 2

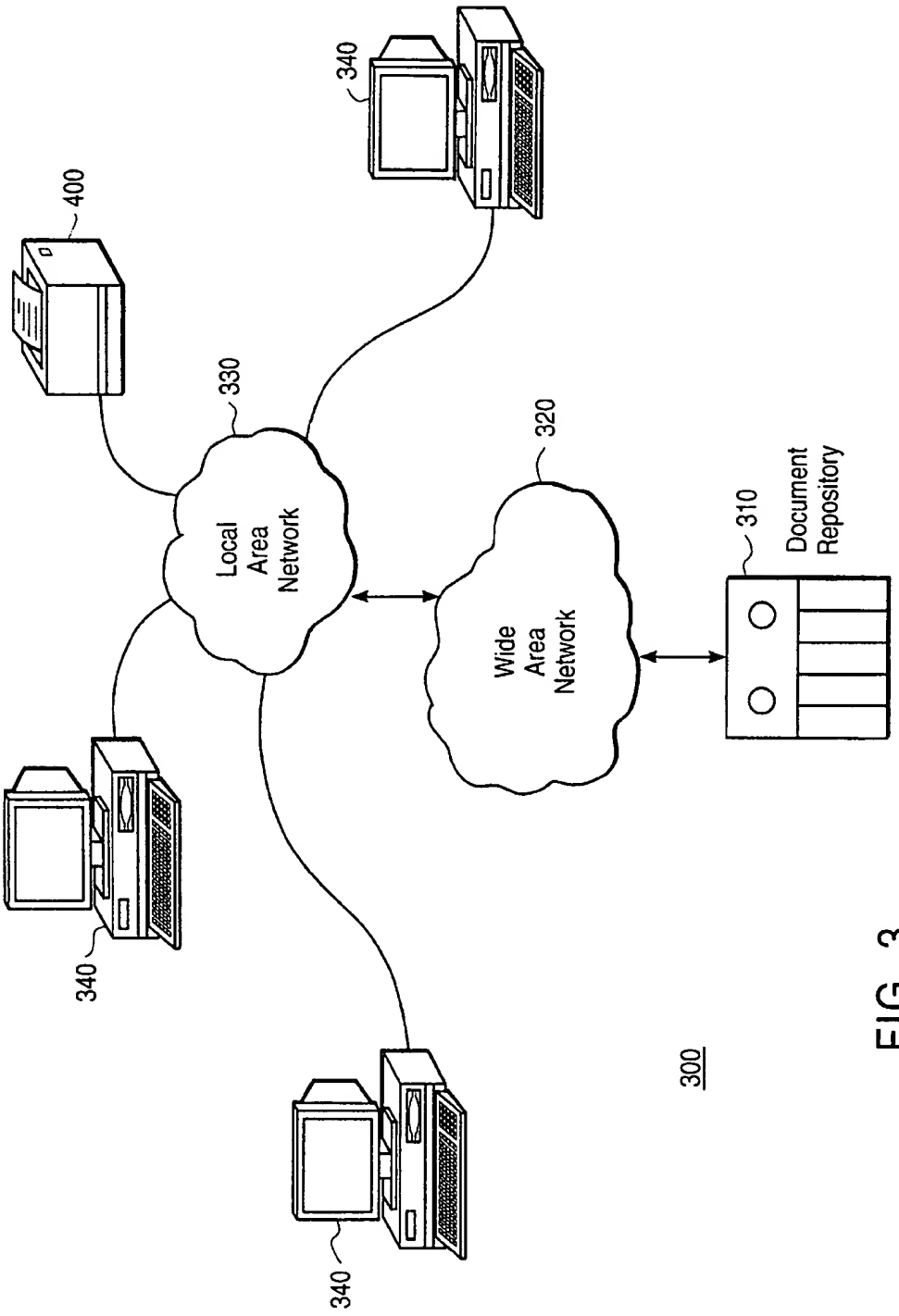

340
400
330
320
310
Document Repository
Local Area Network
Wide Area Network
340
340
300

FIG. 3

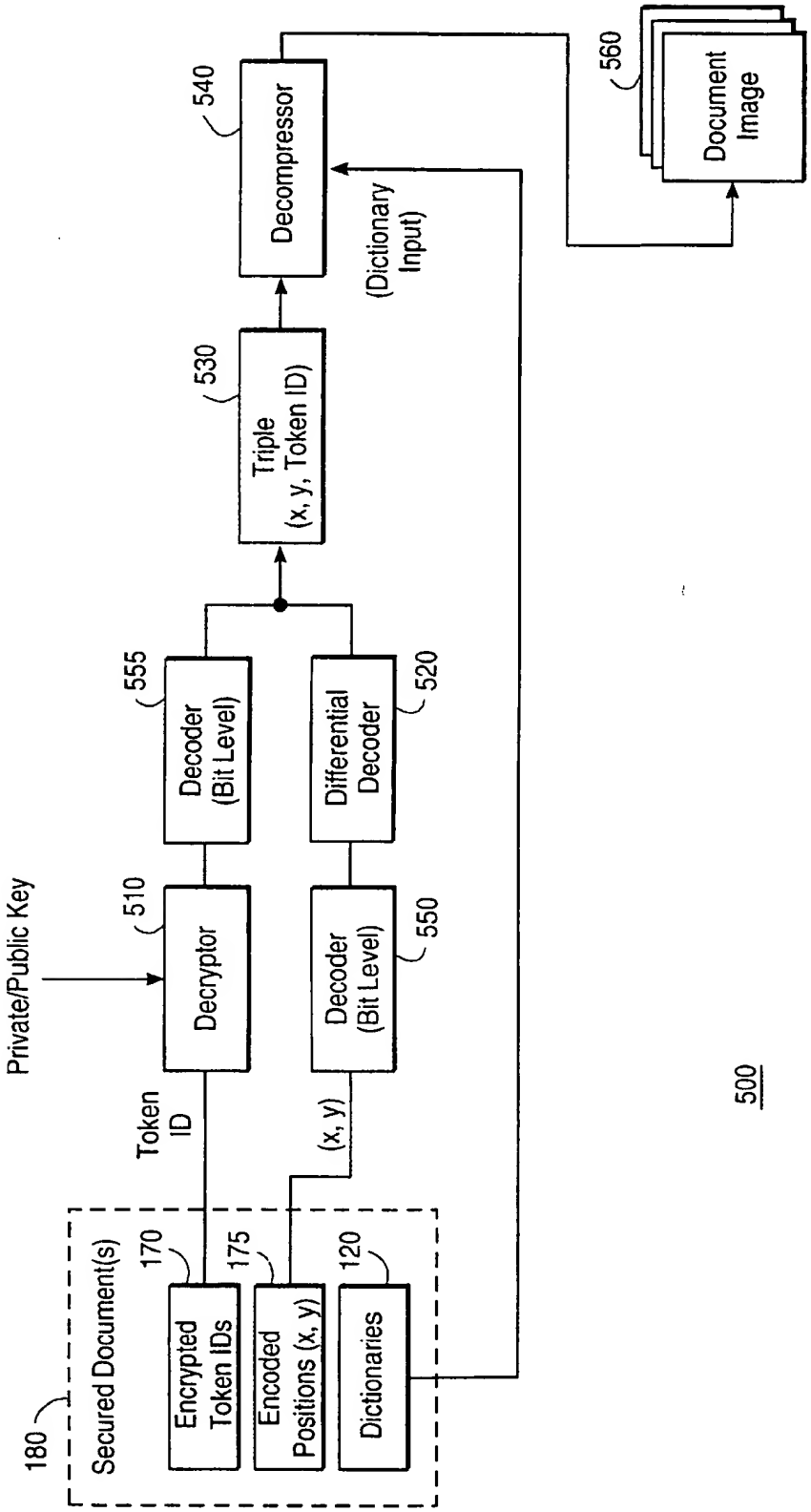

560
Document Image
540
Decompressor
(Dictionary Input)
530
Triple (x, y, Token ID)
555
Decoder (Bit Level)
520
Differential Decoder
Private/Public Key
510
Decryptor
550
Decoder (Bit Level)
Token ID
(x, y)
180
Secured Document(s)
170
Encrypted Token IDs
175
Encoded Positions (x, y)
120
Dictionaries
500

FIG. 4

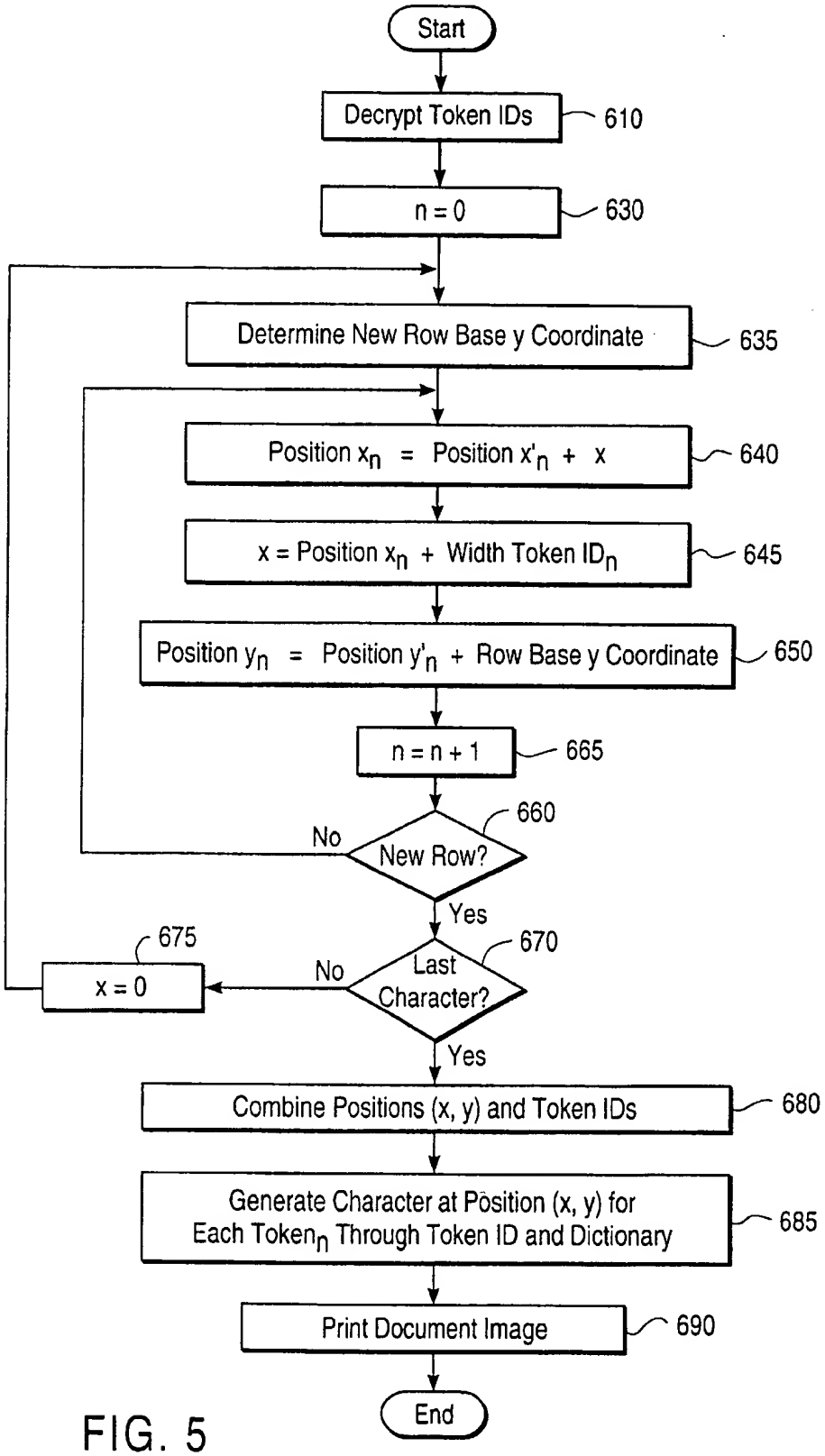

Start
Decrypt Token IDs
610
n = 0
630
Determine New Row Base y Coordinate
635
Position x_n = Position x'_n + x
640
x = Position x_n + Width Token ID_n
645
Position y_n = Position y'_n + Row Base y Coordinate
650
n = n + 1
665
660
No
New Row?
Yes
675
670
x = 0
No
Last Character?
Yes
Combine Positions (x, y) and Token IDs
680
Generate Character at Position (x, y) for Each $Token_n$ Through Token ID and Dictionary
685
Print Document Image
690
End

FIG. 5

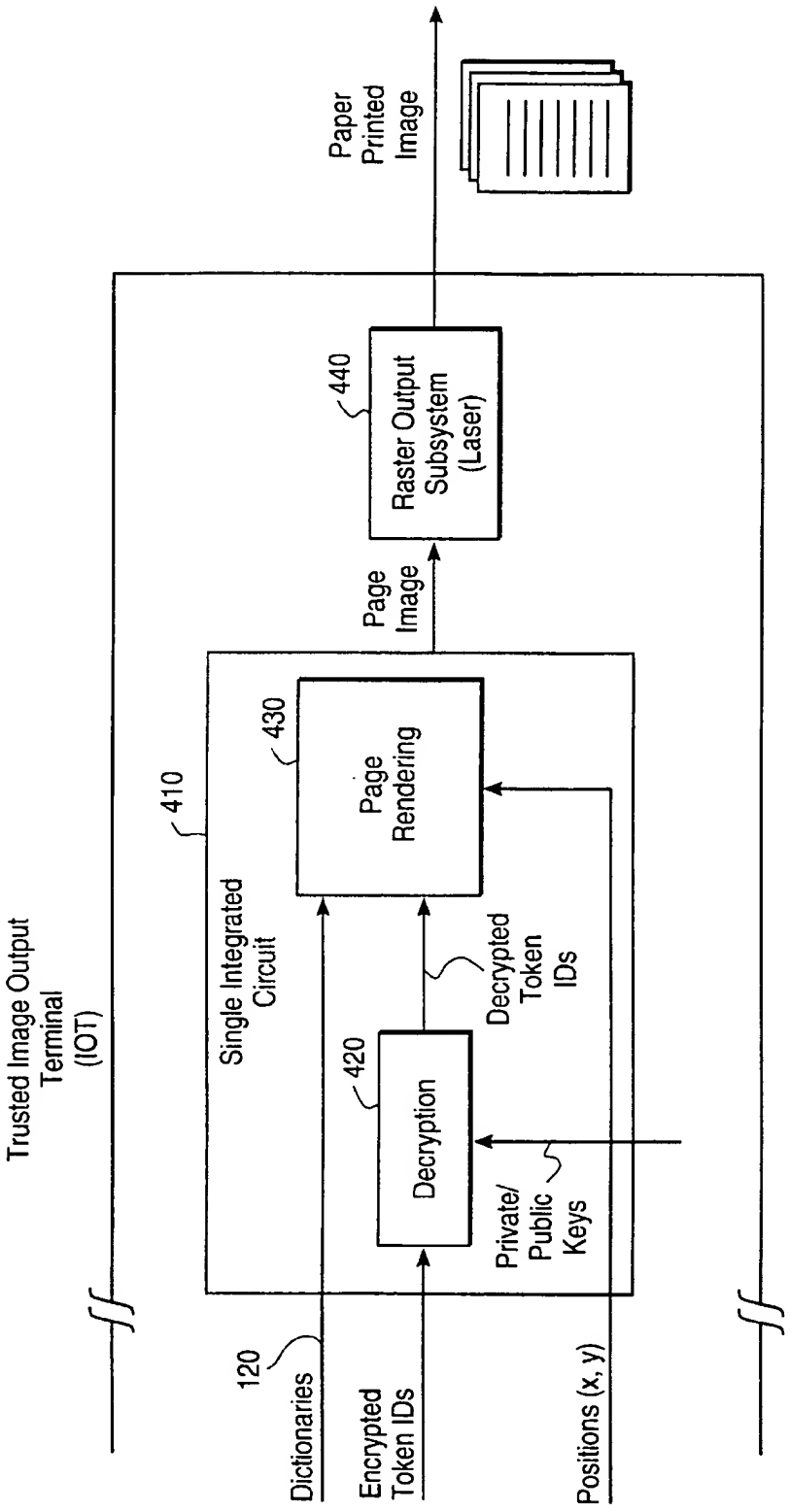

400
Paper Printed Image
440
Raster Output Subsystem (Laser)
Page Image
410
430
Page Rendering
Single Integrated Circuit
Trusted Image Output Terminal (IOT)
Decrypted Token IDs
420
Decryption
Private/ Public Keys
120
Dictionaries
Encrypted Token IDs
Positions (x, y)

FIG. 6

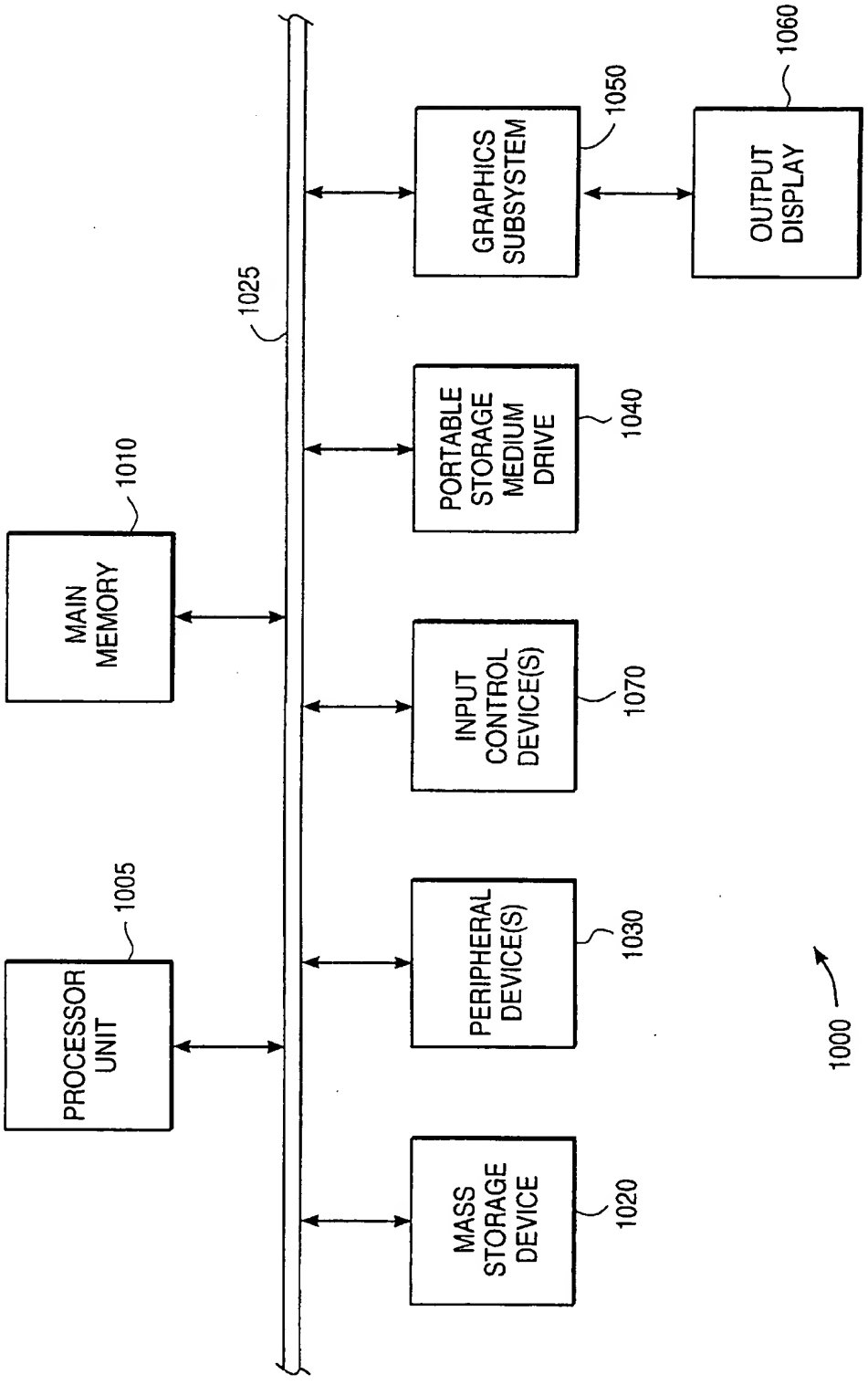

1000
PROCESSOR UNIT
1005
MAIN MEMORY
1010
1025
MASS STORAGE DEVICE
1020
PERIPHERAL DEVICE(S)
1030
INPUT CONTROL DEVICE(S)
1070
PORTABLE STORAGE MEDIUM DRIVE
1040
GRAPHICS SUBSYSTEM
1050
OUTPUT DISPLAY
1060

FIG. 7

METHODS AND APPARATUS FOR PARTIAL ENCRYPTION OF TOKENIZED DOCUMENTS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed toward the field of controlling access to electronic documents, and more particularly toward the field of securing information through partial encryption of tokenized documents.

2. Art Background

Information contained in documents is a valuable commodity in society. The ability to control distribution of documents is partially dependent upon the ownership of intellectual property rights in the documents. One way of generating revenue from the ownership of documents is through the sale or license of the documents. In an outright sale, a user may purchase from an information provider all rights associated with information contained in the document. As an owner of the rights in the document, the user is permitted to copy, distribute, or re-use the information in any form. However, the outright sale of rights in the document may demand a high price. Furthermore, the information provider may not desire to sell all rights in the document. Thus, a purchaser of documents may only want to buy limited rights in documents (i.e., obtain a license for limited rights in the document). One licensing scheme may set a license fee for the document dependent upon the rights conferred to the licensee (i.e., the purchaser of limited rights in the document). For example, a user may purchase from an information provider the right to use a single copy of the document. Having only the right to posses a single copy of the document, the user does not have a right to copy the document or re-use portions of the document. Accordingly, it is desirable for an information provider to control the use of a document by a user based on the rights conferred to the user.

Currently, information and documents are most easily distributed in an electronic form. Electronic documents provide fast, economic and efficient distribution of information not known through conventional techniques of distributing paper or hard copies. However, the distribution of electronic copies of documents significantly increases the issues of access control. Once the user has an electronic document in the clear, the user can easily copy the document, distribute the document, and re-use all or portions of the document to create an additional document. To prevent unauthorized use of an electronic document, information providers may encrypt the electronic version of the document. Encryption, although effective, may require substantial processing resources, and thus encumber the effective use of the electronic document. Accordingly, it is desirable to develop techniques that provide an adequate level of security while minimizing the processing required to recover the document.

SUMMARY OF THE INVENTION

A technique that partially encrypts tokenized documents generates secure documents while minimizing the processing required to reconstruct the document. An electronic document image is generated from the document. A plurality of tokens are stored as a dictionary, wherein the tokens represent shapes contained in the document. A plurality of triples comprising a token identification (ID) and a corresponding position are generated from the document image, such that the token ID identifies a token from the dictionary that corresponds to a shape in the document image at the corresponding position. To secure the contents of the document, the token IDs are encrypted. The secured document comprises encoded positions (x, y), encrypted token IDs and a dictionary of tokens.

In one embodiment, to reduce the size of the secured document, the positions in the sequence of triples are encoded. For this embodiment, the positions are differentially encoded, so as to only store information that identifies a position relative to a proceeding position. In another embodiment, each triple in the sequence is augmented with a color designation to include color in the secured document. If desired, contone color is included in the output representation by augmenting each triple in the sequence with JPEG compressed images.

Document reconstruction in the partial encryption of tokenized document technique includes receiving the dictionary of tokens, encrypted token identification (IDs) and their corresponding positions in the document. The encrypted token IDs are decrypted to generate token IDs. The original document image is then reconstructed from the token IDs and positions by generating a shape corresponding to a shape in the dictionary identified by a token ID at a location identified by a. corresponding position. In one embodiment, a trusted image output terminal includes a single integrated circuit that performs the decrypting function and the page rendering function to significantly reduce the ability to capture signals of the electronic document in the clear.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating one embodiment for partial encryption of tokenized documents.

FIG. **2** is a flow diagram illustrating one embodiment for document generation using the partial encryption of tokenized document techniques of the present invention.

FIG. **3** illustrates a network for transmission of a secured document for use with the present invention.

FIG. **4** is a block diagram illustrating one embodiment for a document reconstruction system for use with the partial encryption of tokenized documents technique.

FIG. **5** is a flow diagram illustrating one embodiment for document reconstruction with partially encrypted tokenized documents.

FIG. **6** is a block diagram illustrating one embodiment for a trusted image output terminal for use with the partial encrypting of tokenized documents technique.

FIG. **7** illustrates a high level block diagram of a general purpose computer system in which the partial encryption of tokenized documents technique of the present invention may be implemented.

DETAILED DESCRIPTION

FIG. **1** is a block diagram illustrating one embodiment for partial encryption of tokenized documents. A document generation system **100** processes document images **110** to generate secured documents **180**. Document images **110** represent a broad category of information residing as electronic images. The document images **110** may include a compilation of information from any source. For example, the document images **110** may be information stored on a computer system as electronic images. Also, the document images **110** may be accessed via a network, and stored at one or more remote locations. The content of document images **110** may include articles, books, periodicals, etc. The docu-

ment images **110** may be stored in any well known format for storing electronic documents.

For the embodiment shown in FIG. **1**, the document images **110** are input to a compressor **130**. In general, the compressor **130** receives, as input, the document images **110**, and generates a compressed version of the document images **110** (i.e, reduces the number of bits required to represent the document image). For this embodiment, the document generation system **100** utilizes a token based document image compression scheme.

In general, token based document image compression involves processing the document images **110**, which represent pages of a document, by searching the document images for distinctive shapes. For example, the letter "T", appearing in a particular font and size, has a distinctive shape. The shape of the letter "T" occurs multiple times throughout the document. For this example, the letter "T" is stored as a shape or token in a collection of dictionaries. For each shape or token encountered in a document, the corresponding shape or token is stored in a dictionary. After compression, the dictionaries contain the individual shapes or tokens that make up the document images. Note that the dictionaries are compilations of shapes only, and they do not reveal how the shapes are arranged in a corresponding document. In the document generation system **100**, the compilation of shapes and tokens for document images **110** is represented as dictionaries **120**.

The compressor **130** generates a position block for each page of the document image. In general, the position block identifies, for each page, locations and the corresponding shape or token that appears in the corresponding position. In the document generation system **100**, the position block is labeled position block **140**, and consists of a stream of triples, (x, y, token ID).

In one embodiment, the document generation system **100** employs a low level encoding scheme to further reduce the size of the document image. The bit level encoding scheme is shown in FIG. **1** as encoding **135**. In one embodiment, encoding **135** employs a Huffman encoding or compression scheme. A bit level encoding scheme, such as Huffman compression, is well known in the art and will not be described further.

As shown in FIG. **1**, the token ID portion of the position block (encoded) is input to encryptor **150**, and the position portion (i.e., x, y) is input to differential encoder **160**. The encryptor **150** encrypts the stream of token IDs for each position block. Any encryption technique may be used to encrypt the stream of token IDs. For example, encryptor **150** may employ a private key cryptography scheme or a public key cryptography scheme. Various techniques for both public key cryptography and private key cryptography are well known in the art and will not be described further.

The position portion (i.e, x, y) of position block **140** is encoded in differential encoder **160** to reduce the size of the position block. Also, bit level encoding is performed in encoding **137** on the differentially encoded positions (x, y). For transmission, the secured document consists of the encoded positions (x, y) and encrypted token IDs. The compilation of shapes for dictionaries **120** are also transmitted with the document, and thus are part of secured document **180** as well.

FIG. **2** is a flow diagram illustrating one embodiment for document generation using the partial encryption of tokenized document techniques of the present invention. As shown in block **200**, the document images are parsed into tokens or shapes per the compilation of shapes in the dictionaries **120**. For each token, token$_n$, a triple (x, y, token ID)$_n$, is generated as shown in block **210**. The (x, y) identifies the position, and the token ID identifies the corresponding shape at that position. As shown in block **220**, the stream of triples, (x, y, token ID)$_n$, is separated into two streams: positions (x, y)$_n$ and token IDs$_n$. The stream of token IDs are encrypted (block **230**).

The differential encoding of the position block improves compression by utilizing the fact that the token positions are not randomly distributed. Instead, in one embodiment, the token positions are organized into lines of text. For this embodiment, the differential encoder **160** (FIG. **1**) encodes the token positions in generally the order in which the document images are read (i.e., line by line from left to right). To implement this embodiment, the triples are sorted into a general approximation of text lines organized from top-to-bottom. For each text line, the triples are sent left-to-right. As discussed below, the encoding reflects the space between the previous token's right-hand edge and the current token's left-hand edge.

For the embodiment of FIG. **2**, differential encoding is used to further reduce the size of positions in the position block. For each "x" position of a triple, the differential encoder **160** encodes the difference from the "x" position of the previous triple minus the width in pixels of the previous triple's token. For example, if the horizontal or x position for a position block is 100, the token ID corresponding to the position x_n is 8 pixels in length, and there are two additional spaces between where position x_n and the proceeding image, then differentially encoded position x_n is stored as "2". Specifically, for each position, position x_n, and a subsequent position in a single row, a difference between the prior position and the subsequent position is calculated to generate the differentially encoded position, position x_n. As shown in blocks **250** and **255**, position x_n is calculated by subtracting "x" from the current position X_n, and updating x to be the current position. To differentially encode the vertical position y, entitled position y_n, the position for the current row is subtracted from the current character, thereby storing only the difference. This expression is shown in block **260** of FIG. **2**. For example, if the vertical position for position y_n is 50, and the current base y coordinate is 50, then the position y_n is 0 (i.e., there is no difference between the vertical positions of this token ID and the current row). The algorithm for differentially encoding the position portion of the position block is shown in blocks **240**, **250**, **255**, **260**, **265**, **270**, **280** and **285** of FIG. **2**.

As shown in block **290** of FIG. **2**, the secured document, which includes the encrypted token IDs and differentially encoded positions, are assembled to create, in part, the secured document. The encrypted token IDs and positions along with the compilation of dictionaries, are now available for use as a secured document. For example, the secured document may be transmitted to a designated recipient (block **295**).

In one embodiment, the partial encryption of tokenized documents technique includes documents with color. For this embodiment, color information is included in the secured document **180** by labeling each position block (x, y), with the corresponding color. In the document reconstruction system (FIG. **5**), the color information for a position is extracted to generate color at the corresponding position on a document image. Contone color information is included by adding to a document page JPEG-compressed images. The contone color is drawn as background to the document image page. Alternatively, the contone color information may be clipped by a mask during document reconstruction.

The partial encryption of token based documents technique of the present invention is an efficient technique that provides relatively high security. The technique, which only encrypts the sequence of token IDs and leaves the encoded positions, token dictionaries and color information in the clear, substantially reduces the amount of processing to recover a secured document from a technique that encrypts the entire position block. Typically, the token ID stream accounts for approximately 10 to 30% of the bits in the document. Accordingly, there is, on average, a five-fold reduction in the number of bits that must be encrypted to generate a document and that must be decrypted to recover a document. This efficiency is on top of the reduction in the document image file size obtained by using a token-based document representation. Typically, a token-based document representation reduces the file size between three to ten times the original size. Accordingly, overall, the partially encrypted token based document compression has approximately thirty times fewer encrypted bits than the number of bits that would be required to fully encrypt the original document images.

Security of Partial Encryption of Tokenized Documents:

The partial encryption of tokenized documents technique of the present invention provides a fairly high level of security that protects unauthorized copying of a secured document. However, this technique does provide the untrusted user access to some of the information contained in the secured document. The dictionaries **120** (FIG. 1), which are sent in the clear,. contain only shapes. No position information that identifies where the shape occurs in the document is provided with the dictionaries. Thus, the ability to read the dictionaries only allows the untrusted user to see what shapes are used in the documents. This is equivalent to knowing what fonts were used to construct the documents.

Some documents may include a shape that appears only once in the document. For example, a line drawing unique to a particular document may occur only a single time in the document. Thus, these shapes are visible to the untrusted user in the dictionaries. In one embodiment, to protect the content information of the character, the character is encrypted. For this embodiment, additional processing is required to decrypt and to uncover the secured document. In another embodiment, the unique shape is partitioned into arbitrary sub-shapes. For example, if the unique shape is a line, then the line is divided into smaller line segments. For this embodiment, the original shape is reconstructed in the document reconstruction system (FIG. **5**). The sub-shapes stored in the dictionaries contain little information. This technique of dividing original shapes into sub-shapes increases the compression ratio in the compressor **130** (FIG. 1) because multiple triples must be used to instruct the document reconstruction system (FIG. **5**) on how and where to reconstruct the sub-shapes. However, this technique does not increase the amount of processing required to encrypt the token IDs.

The position information (i.e., x, y) in the position block **140** is not enough information to reconstruct the content of the document. The information encoded in the differential encoder **160** (FIG. **1**) is a sequence of inter-character spaces from which the untrusted user could gain little information. However, it is possible to extract, to some degree of accuracy, the word length and to identify characters that have descenders. The ability to extract this information may be reduced by using a more sophisticated position block encoder (i.e., more sophisticated than the differential coding technique). An untrusted user could, using natural language models and having an expectation of the document contents, reconstruct some of the text of the document. Accordingly, this technique may not be the preferred technique for highly sensitive and confidential documents. However, for most applications involving documents whose content is not extremely sensitive, the techniques of the present invention provide adequate protection.

The color information, if present in the secured document, is also not very useful to the untrusted user in determining the content of the document. In general, the color information only discloses that some sequence of tokens occurred in a particular color. The color information is sent in the clear (i.e., the color information in the position block is not encrypted). Since the color information is available to the trusted printer (FIG. **6**) prior to decryption processing, the untrusted component of the printer performs pre-processing steps using the color information. For example, the untrusted component of the printer may pre-process trapping or line thickening using the color and shape information. This further reduces the amount of processing required in the "trusted component" portion of the printer, thereby reducing the ability to compromise the secured document.

The contone information, if present, is also sent in the clear (i.e., the contone information is not encrypted). If the principal value of the document is a collection of images represented in the contone information, then sending contone information in the clear is not an appropriate technique. Sending the contone information in the clear is an attempt to prevent access to the textual portion of the document, and thus assumes that the text is the valuable portion of the document.

Secured Document Distribution:

FIG. **3** illustrates a network for transmission of a secured document for use with the present invention. Documents **180** are stored in a document repository **310**. Document repository **310**, depicted as a large storage medium in FIG. **3**, represents a broad category of storage devices suitable for storing a repository of documents. The documents are stored in the document repository **310** as "secured documents" **180** (i.e., the documents are processed to include partial encryption of tokenized documents). For the example document distribution system shown in FIG. **3**, the document repository **310** is coupled to a wide area network **320**. Wide area network **320** represents a broad category of transmission medium used to distribute information globally. Local area network **330** is also shown on FIG. **3**. Local area network **330** couples a plurality of personal computers, labeled **340**. A trusted printer **400** is also coupled to the local area network **330**. For purposes of illustration, the personal computers **340** transmit electronic documents to trusted printer **400** to obtain paper printed images of documents.

For the example network shown in FIG. **3**, secured documents **180** are transmitted to one or more personal computers **340** via wide area network **320** and local area network **330**. The secured documents **180** may be stored on a server for the local area network **330** or any one or more of the personal computers **340**. At this point, the secured document cannot be viewed electronically by a user of a personal computer **340**. Thus, even if a user makes multiple copies of a document in an electronic form, the secured document is not useful to the user.

To view the content of the secured document in the example of FIG. **3**, the user transmits the secured documents **180** to the trusted printer **400**. The document reconstruction system (FIG. **5**) is implemented in the trusted printer **400**. As such, the trusted printer **400** decompresses and decrypts the secured document **180** and prints a document image on paper. The user may then view the document as a hard copy.

Document Reconstruction:

FIG. **4** is a block diagram illustrating one embodiment for a document reconstruction system for use with the partial encryption of tokenized documents technique. A document reconstruction system **500** receives, as an input, secured documents **180**, and generates, as an output, a document image **560**. As described below, the document image **560** may be a hard copy printed on paper (See FIGS. **3** and **6**). As discussed above, the secured documents **180** include the encrypted token IDs, positions and dictionaries **120**. The encrypted token IDs **170** are input to decryptor **510**. The decryptor **510** decrypts the token IDs in accordance with the encryption scheme used in the encryptor **150** (FIG. **1**). Also, as shown in FIG. **4**, decryptor **510** receives a private/public key from an individual authorized to view the document. A decoder, labeled **550** on FIG. **4**, decodes the positions (x, y) on a bit level. A differential decoder **520** receives the positions from the decoder **550**, and differentially decodes the positions. A bit level decoder **555** decodes the token IDs in accordance with the encoding **135** (FIG. **1**) scheme. As shown in FIG. **4**, the position block is re-combined into a stream of triples **530** with the decoded position (x, y) and the decrypted token ID. The stream of triples **530** is then input to decompressor **540**. Decompressor **540** receives dictionaries **120** to generate shapes designated by token IDs at the corresponding positions (x, y). The output of document reconstruction system **500**, in a human readable form, is shown as document image **560**.

FIG. **5** is a flow diagram illustrating one embodiment for document reconstruction with partially encrypted tokenized documents. The secured document is divided into positions (x, y) and token IDs for each of "n" tokens in the document (block **600**). With user provided keys, the token IDs are decrypted (block **610**). The positions (x, y) are differentially decoded as set forth in the algorithm in blocks **630, 635, 640, 645, 650, 660, 665, 670** and **675**. Although differential encoding/decoding is described herein, any technique that reduces the ability to derive the content information from the position information and dictionaries may be used without deviating from the spirit or scope of the invention. The positions (x, y) and corresponding token IDs are recombined (block **680**). Shapes from the dictionaries, identified by the token IDs, are generated at the corresponding positions (block **685**). The document is printed on paper to provide a hard copy of the document (block **690**).

FIG. **6** is a block diagram illustrating one embodiment for a trusted image output terminal for use with the partial encrypting of tokenized documents technique. A trusted image output terminal **400** includes, in part, a document reconstruction system implemented on a single integrated circuit **410**. In one embodiment, the trusted image output terminal **400** is a laser printer; however, any printing technology may be used in conjunction with the techniques of the present invention. As shown in FIG. **6**, the single integrated circuit **410** includes decryption **420** and page rendering **430**. In general, the decryption **420** receives the encrypted token IDs and public/private keys, and generates decrypted token IDs. The token IDs, dictionaries, and positions (x, y) are input to page rendering **430**. Page rendering **430** decodes the positions (x, y), and decompresses the positions (x, y) and token IDs to generate a page image. The page image is the output of the integrated circuit **410**. A raster output subsystem **440** (laser) receives the page image, and generates the page image on paper to produce a hard copy of the document. In one embodiment, the single integrated circuit **410** is implemented with an application specific integrated circuit chip (ASIC).

As shown on FIG. **6**, the processing to decrypt the token IDs and to render the page images are successive. This allows implementation of both the decryption and page rendering functions in the single integrated circuit **410**. Integrating the decryption and page rendering functions in a single integrated circuit **410** makes access to the decrypted token ID stream extremely difficult. For example, an untrusted user tampering with the trusted image output terminal in an attempt to capture the decrypted document in electronic form would have to access internal data paths in the single integrated circuit **410**. This task is extremely difficult. As shown by the lines in FIG. **6**, the untrusted user may capture the partially encrypted data stream external to the single integrated circuit chip **410**. However, the user already has access to the partially encrypted tokenized document. On the output of the integrated circuit chip **410**, an untrusted user could capture the page image. However, capturing the page image is equivalent to a noise-free scanning of the paper that the printer produces. At the output stage of the single integrated circuit, printing of the paper image is imminent. Based on the trusted image output terminal **400** of FIG. **6** and a document distribution network example of FIG. **3**, an untrusted user cannot gain access to the decrypted electronic version of the document, and therefore cannot make unauthorized copies of the electronic version of the document.

Computer System:

FIG. **7** illustrates a high level block diagram of a general purpose computer system in which the partial encryption of tokenized documents technique of the present invention may be implemented. A computer system **1000** contains a processor unit **1005**, main memory **1010**, and an interconnect bus **1025**. The processor unit **1005** may contain a single microprocessor, or may contain a plurality of microprocessors for configuring the computer system **1000** as a multiprocessor system. The main memory **1010** stores, in part, instructions and data for execution by the processor unit **1005**. If the partial encryption of tokenized documents technique of the present invention is wholly or partially implemented in software, the main memory **1010** stores the executable code when in operation. The main memory **1010** may include banks of dynamic random access memory (DRAM) as well as high speed cache memory.

The computer system **1000** further includes a mass storage device **1020**, peripheral device(s) **1030**, portable storage medium drive(s) **1040**, input control device(s) **1070**, a graphics subsystem **1050**, and an output display **1060**. For purposes of simplicity, all components in the computer system **1000** are shown in FIG. **7** as being connected via the bus **1025**. However, the computer system **1000** may be connected through one or more data transport means. For example, the processor unit **1005** and the main memory **1010** may be connected via a local microprocessor bus, and the mass storage device **1020**, peripheral device(s) **1030**, portable storage medium drive(s) **1040**, graphics subsystem **1050** may be connected via one or more input/output (I/O) busses. The mass storage device **1020**, which may be implemented with a magnetic disk drive or an optical disk drive, is a non-volatile storage device for storing data and instructions for use by the processor unit **1005**. In the software embodiment, the mass storage device **1020** stores the partial encryption of tokenized documents software for loading to the main memory **1010**.

The portable storage medium drive **1040** operates in conjunction with a portable non-volatile storage medium, such as a floppy disk or a compact disc read only memory (CD-ROM), to input and output data and code to and from

the computer system **1000**. In one embodiment, the partial encryption of tokenized documents software is stored on such a portable medium, and is input to the computer system **1000** via the portable storage medium drive **1040**. The peripheral device(s) **1030** may include any type of computer support device, such as an input/output (I/O) interface, to add additional functionality to the computer system **1000**. For example, the peripheral device(s) **1030** may include a network interface card for interfacing the computer system **1000** to a network. For the software implementation, documents may be input to the computer system **1000** via a portable storage medium or a network for processing by the partial encryption of tokenized documents software.

The input control device(s) **1070** provide a portion of the user interface for a user of the computer system **1000**. The input control device(s) **1070** may include an alphanumeric keypad for inputting alphanumeric and other key information, a cursor control device, such as a mouse, a trackball, stylus, or cursor direction keys. In order to display textual and graphical information, the computer system **1000** contains the graphics subsystem **1050** and the output display **1060**. The output display **1060** may include a cathode ray tube (CRT) display or liquid crystal display (LCD). The graphics subsystem **1050** receives textual and graphical information, and processes the information for output to the output display **1060**. The components contained in the computer system **1000** are those typically found in general purpose computer systems, and in fact, these components are intended to represent a broad category of such computer components that are well known in the art.

The partial encryption of tokenized document techniques, including the document generation system and the document reconstruction system may be implemented in either hardware or software. For the software implementation, the document generation and document reconstruction systems are software that includes a plurality of computer executable instructions for implementation on a general purpose computer system. Prior to loading into a general purpose computer system, the document generation and document reconstruction system software may reside as encoded information on a computer readable medium, such as a magnetic floppy disk, magnetic tape, and compact disc read only memory (CD-ROM). In one hardware implementation, the document generation and document reconstruction systems may comprise circuits, implemented on a single integrated circuit as shown in FIG. **6**.

Although the present invention has been described in terms of specific exemplary embodiments, it will be appreciated that various modifications and alterations might be made by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A method for partially encrypting a tokenized document, said method comprising the steps of:

generating, from a document, a document image;

storing a plurality of tokens for use as at least one dictionary, wherein a token represents a shape;

generating, from said document image, a plurality of triples comprising a token identification (ID) and a corresponding position in said document image, wherein said token ID identifies a token from said dictionary that corresponds to a shape in said document image at said corresponding position; and

encrypting said token IDs, wherein an output representation for said document comprises encrypted token IDs, positions, and a dictionary of tokens.

2. The method as set forth in claim **1**, further comprising the step of encoding said positions so as to reduce the information between two successive positions in said output representation.

3. The method as set forth in claim **2**, wherein the step of encoding said positions comprises the step of differentially encoding information between two successive positions.

4. The method as set forth in claim **1**, further comprising the step of transmitting said output representation comprising said encrypted token IDs, said positions, and said dictionary of tokens.

5. The method as set forth in claim **1**, further comprising the step of assigning each position with a color designation to include color in said output representation of said document.

6. The method as set forth in claim **1**, further comprising the step of augmenting each position in said sequence with JPEG compressed images to include contone color in said output representation.

7. A method for reconstructing a tokenized document, said method comprising the steps of:

receiving at least one dictionary comprising a plurality of tokens, wherein a token represents a shape;

receiving a representation for a document comprising a plurality of encrypted token identifications (IDs) and corresponding positions in said document image, such that a token ID identifies a token from said dictionary that corresponds to a shape in said document image at a corresponding position;

decrypting said encrypted token IDs to generate token IDs; and

generating a document image by generating a shape corresponding to a shape in said dictionary identified by a token ID at a location identified by a corresponding position.

8. The method as set forth in claim **7**, further comprising the steps of:

receiving encoded positions; and

decoding said encoded positions.

9. The method as set forth in claim **8**, wherein the step of decoding said encoded positions comprises the step of differentially decoding two successive positions to obtain absolute coordinates for said positions.

10. The method as set forth in claim **7**, further comprising the steps of:

receiving a color designation for at least one position; and

generating color at said position in accordance with said color designation.

11. The method as set forth in claim **7**, further comprising the steps of:

receiving contone color for at least one position; and

generating for said position contone color in said document image.

12. An image output terminal for printing a document image comprising:

decryption circuitry for receiving a plurality of encrypted token identifications (IDs) and for decrypting said encrypted token IDs to generate token IDs;

page rendering circuitry for receiving positions corresponding to said token IDs and at least one dictionary comprising a plurality of tokens that represent shapes, said page rendering circuitry being coupled to said decryption circuitry for receiving said token IDs, and for generating a page image from said token IDs, dictionary and positions through identification of tokens from said dictionary that corresponds to a shape in said document image at said corresponding position; and

a raster output subsystem coupled to said page rendering circuitry for receiving said page image and for generating a paper printed image.

13. The image output terminal as set forth in claim 12, wherein said decryption circuitry and said page rendering circuitry comprise a single integrated circuit device.

14. A computer readable medium comprising a set of instructions stored therein, which when executed by a computer, causes the computer to perform the steps of:

generating, from a document, a document image;

storing a plurality of tokens for use as at least one dictionary, wherein a token represents a shape;

generating, from said document image, a plurality of triples comprising a token identification (ID) and a corresponding position in said document image, wherein said token ID identifies a token from said dictionary that corresponds to a shape in said document image at said corresponding position; and

encrypting said token IDs, wherein an output representation for said document comprises encrypted token IDs, positions, and a dictionary of tokens.

15. The computer readable medium as set forth in claim 14, further comprising the step of assigning each position with a color designation to include color in said output representation of said document.

16. The computer readable medium as set forth in claim 15, wherein the step of encoding said positions comprises the step of differentially encoding information between two successive positions.

17. The computer readable medium as set forth in claim 14, further comprising the step of transmitting said output representation comprising said encrypted token IDs, said positions, and said dictionary of tokens.

18. The computer readable medium as set forth in claim 14, further comprising the step of assigning each position with a color designation to include color in said output representation of said document.

19. The computer readable medium as set forth in claim 14, further comprising the step of augmenting each position in said sequence with JPEG compressed images to include contone color in said output representation.

20. A computer readable medium comprising a set of instructions stored therein, which when executed by a computer, causes the computer to perform the steps of:

receiving at least one dictionary comprising a plurality of tokens, wherein a token represents a shape;

receiving a representation for a document comprising a plurality of encrypted token identifications (IDs) and corresponding positions in said document image, such that a token ID identifies a token from said dictionary that corresponds to a shape in said document image at a corresponding position;

decrypting said encrypted token IDs to generate token IDs; and

generating a document image by generating a shape corresponding to a shape in said dictionary identified by a token ID at a location identified by a corresponding position.

21. The computer readable medium as set forth in claim 20, further comprising the steps of:

receiving encoded positions; and

decoding said encoded positions.

22. The computer readable medium as set forth in claim 21, wherein the step of decoding said encoded positions comprises the step of differentially decoding two successive positions to obtain absolute coordinates for said positions.

23. The computer readable medium as set forth in claim 20, further comprising the steps of:

receiving a color designation for at least one position; and

generating color at said position in accordance with said color designation.

24. The computer readable medium as set forth in claim 20, further comprising the steps of:

receiving contone color for at least one position; and

generating for said position contone color in said document image.

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